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Claims

[c1] 1. A method for determining driving wheel torque for a vehicle having a hybrid electric powertrain, the powertrain comprising an engine, an electric motor, a battery, a generator and gearing that define plural torque flow paths from the engine and the motor to a torque output shaft, the method comprising:
calculating angular acceleration of the motor;
calculating angular acceleration of the engine;
calculating moments of inertia of the motor and the generator;
calculating static gearing output torque and motor torque; and
estimating total wheel torque as a function of operating variables including inertia of both the motor and the generator, angular acceleration of the engine, motor torque and torque ratio from the motor to the vehicle wheels.

[c2] 2. A method for determining driving wheel torque for a vehicle having a hybrid electric powertrain with a parallel operating mode, the powertrain comprising an engine, an electric motor, a battery, a generator and gearing that

define plural torque flow paths from the engine and the motor to a torque output shaft, the method comprising:
calculating angular acceleration of the motor;
calculating angular acceleration of the engine;
calculating moments of inertia of the motor, the engine and the generator;
calculating static gearing output torque and motor torque; and
estimating total wheel torque as a function of operating variables including inertia of both the motor and the generator, angular acceleration of the engine, motor torque and torque ratio from the motor to the vehicle wheels.

[c3] 3. A method for determining driving wheel torque for a vehicle having a hybrid electric powertrain with a non-parallel operating mode, the powertrain comprising an engine, an electric motor, a battery, a generator and gearing that define plural torque flow paths from the engine and the motor to vehicle wheels, the method comprising:
calculating angular acceleration of the motor;
calculating angular acceleration of the engine;
calculating moments of inertia of the motor and the generator;
calculating static gearing output torque and motor

torque during operation in the non-parallel mode as a function of torque ratio from the generator to the motor and generator torque; and

estimating total wheel torque as a function of operating variables including inertia of both the motor and the generator, angular acceleration of the engine, motor torque and torque ratio from the motor to the vehicle wheels.

[c4] 4. A method for determining driving wheel torque for a vehicle having a hybrid electric powertrain with non-parallel and parallel operating modes, the powertrain comprising an engine, an electric motor, a battery, a generator and gearing that define plural torque flow paths from the engine and the motor to vehicle wheels, the method comprising:

calculating angular acceleration of the motor;

calculating angular acceleration of the engine;

calculating moments of inertia of the motor, the engine and the generator; and

calculating static gearing output torque during operation in the parallel mode as a function of operating variables including torque ratio from the generator to the motor, engine torque, engine moment of inertia and engine angular acceleration.

[c5] 5. The method set forth in claim 1 wherein estimated total wheel torque is computed in accordance with the equation:

$$\tau_{total\_wheel} = T_{mot2wheel} * (\tau_{mot} - \tau_{p@mot} + J_{gen\_couple} * dot\omega_{eng} - J_{mot\_eff} * dot\omega_{eng})$$

where:

τ_{total_wheel} = total wheel torque estimate;

$T_{mot2wheel}$ = torque ratio from motor to wheels;

$\tau_{p@mot}$ = torque @ motor shaft;

J_{gen_couple} = coupled moment of inertia of generator and the gear element to which it is connected;

$dot\omega_{eng}$ = engine angular acceleration;

J_{mot_eff} = sum of the lumped motor and gearing inertia and the lumped generator inertia reflected at the motor; and

τ_{mot} = motor torque.

[c6] 6. The method set forth in claim 2 wherein estimated total wheel torque is computed in accordance with the equation:

$$\tau_{total\_wheel} = T_{mot2wheel} * (\tau_{mot} - \tau_{p@mot} + J_{gen\_couple} * dot\omega_{eng} - J_{mot\_eff} * dot\omega_{eng})$$

where:

τ_{total_wheel} = total wheel torque estimate;

$T_{mot2wheel}$ = torque ratio from motor to wheels;

$\tau_{p@mot}$ = torque @ motor shaft;

J_{gen_couple} = coupled moment of inertia of generator and the gear element to which it is connected;

$dot\omega_{eng}$ = engine angular acceleration;

J_{mot_eff} = sum of the lumped motor and gearing inertia and the lumped generator inertia reflected at the motor; and

τ_{mot} = motor torque.

[c7] 7. The method set forth in claim 3 wherein estimated total wheel torque is computed in accordance with the equation:

$$\tau_{total\_wheel}=T_{mot2wheel}*(\tau_{mot}-\tau_{p@mot}+J_{gen\_couple}*dot\omega_{eng}-J_{mot\_eff}*dot\omega_{eng})$$

where:

τ_{total_wheel} = total wheel torque estimate;

$T_{mot2wheel}$ = torque ratio from motor to wheels;

$\tau_{p@mot}$ = torque @ motor shaft;

J_{gen_couple} = coupled moment of inertia of generator and the gear element to which it is connected;

$dot\omega_{eng}$ = engine angular acceleration;

J_{mot_eff} = sum of the lumped motor and gearing inertia and the lumped generator inertia reflected at the motor; and

τ_{mot} = motor torque.

[c8] 8. The method set forth in claim 3 wherein static gearing output torque is computed in accordance with the equa-

tion:

$\tau_{p@mot} = T_{gen2mot} * \tau_{gen}$

where:

$\tau_{p@mot}$ = torque at motor shaft;

$T_{gen2mot}$ = torque ratio from generator to motor shaft;

and

τ_{gen} = generator torque.

[c9] 9. The method set forth in claim 4 wherein static gearing output torque is computed in accordance with the equation:

$\tau_{p@mot} = -T_{gen2mot} * (\tau_{eng} - J_{eng} * dot\omega_{eng})$

where:

$\tau_{p@mot}$ = torque at motor shaft;

$T_{gen2mot}$ = torque ratio from engine to motor shaft;

τ_{eng} = engine torque;

J_{eng} = lumped moment of inertia of engine and the element of the gearing to which it is connection; and

$dot\omega_{eng}$ = engine angular acceleration.